THE ELEMENTAL ABUNDANCE OF MAGNESIUM IN SOLAR WIND SAMPLES (SILICON AND DIAMOND-LIKE CARBON) RETURNED BY GENESIS.* I. V. Veryovkin[1](email: veryovkin@anl.gov), C. E. Tripa[1], M. J. Pellin[1], M. R. Savina[1], and D. S. Burnett[2], [1]Materials Science Division, Argonne National Laboratory, 9700 S. Cass Ave., Argonne, IL 60439 [2]Division of Geological and Planetary Sciences, Mail Code 100-23, California Institute of Technology, Pasadena, CA. 91125.

The samples returned to Earth by the Genesis Discovery Mission [1] contain a record of the elemental and isotopic abundances of the solar wind. Among the various high purity materials which acted as collectors for the solar wind are silicon and diamond-like carbon (DLC).[2] Here we detail the elemental and isotopic Mg fluence of the solar wind in these two separate collector materials as measured by RIMS.

Preliminary measurements of the Mg solar wind fluence from Genesis Si collectors were reported last year both from SIMS ($2.1x10^{12}$ atoms/cm^2) [3] and RIMS ($1.02\ x10^{12}$ ^{24}Mg atoms/cm^2).[4] Other estimates of the composition of both the photosphere and solar wind have been made through various determinations.[5] Some solar wind abundances have been determined previously by examining foil collectors from Apollo and directly from unmanned missions, including ACE, WIND and SOHO. However, the sum total of all data collected lacks the completeness and accuracy needed to test current models of solar system formation. The goal of Genesis is to obtain a comprehensive set of elemental and isotopic abundances at significantly higher precision and accuracy levels than presently available.

Measurements reported here were accomplished with a secondary neutral mass spectrometry (SNMS) instrument implementing resonance enhanced multiphoton ionization (REMPI) of ion sputtered desorbed neutral species. This instrument was developed and constructed specifically for quantitative analysis of metallic elements at ultra trace levels in the solar wind collectors returned by the Genesis spacecraft. This resonance ionization mass spectrometry (RIMS) instrument has been described elsewhere in detail. [6] Since accurate quantitative analysis is compromised by sample contamination, several features have been built into the new RIMS instrument to mitigate this difficulty.[7] The main advantages of the instrument are its sensitivity, accuracy and selectivity. The RIMS technique has been shown to be capable of quantitative sub-parts per billion determinations while consuming little sample.[8]

The solar wind composition of the various metallic elements range from above one part per million ($>10^{-6}$) to below one part per trillion ($<10^{-12}$) and are embedded within 100 nm of the surface, [1] making analysis a challenging proposition but well suited for RIMS. The first measurements have focused on determining Mg in Genesis samples. These measurements will determine concentrations and isotopic abundances and help elucidate fractionation effects between the photosphere and the solar wind compositions due to first ionization potential fractionation. Since these elements are present in relatively high concentrations, these measurements also serve as a useful first test of the RIMS method and will help to better identify sample contamination problems.

Genesis samples have been found to be contaminated by a thin film deposited during flight and by particles introduced when the Sample Return Capsule was breached during its crash landing. The ubiquitous nature of Mg makes it an ideal candidate to examine whether surface contamination will limit the accuracy or precision of the RIMS measurements. Previously, we have demonstrated that the SARISA instrument can isolate the surface contamination from the implanted ions.[4] This ability is clearly evident in the isolation in depth of the surface contamination peak and the measured depth distributions of implant standards and Genesis flight coupons in both Si and DLC substrates (**Figs. 1, 2 and 3**). The ability to identify particulate contamination arises from two separate instrument aspects. First the integral optical microscope[7] allows the operator to choose locations on the sample surface where scratches and particulates are not present. For

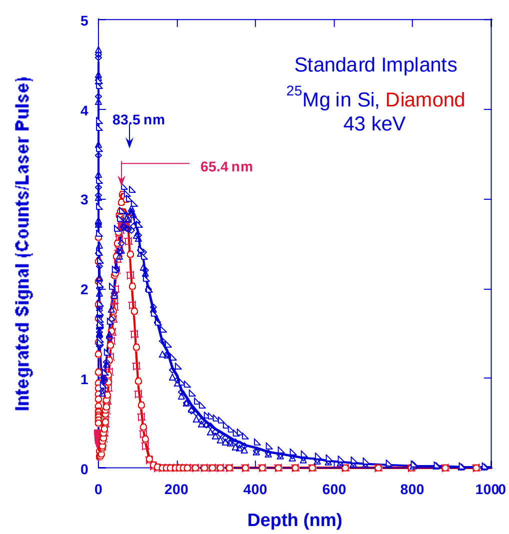

Figure 1. RIMS depth profile of implant standards. Each Data Point represents an individual RIMS measurement. Displayed are three separate measurements of the Si standard and two separate profiles in the diamond standard. The solid lines are

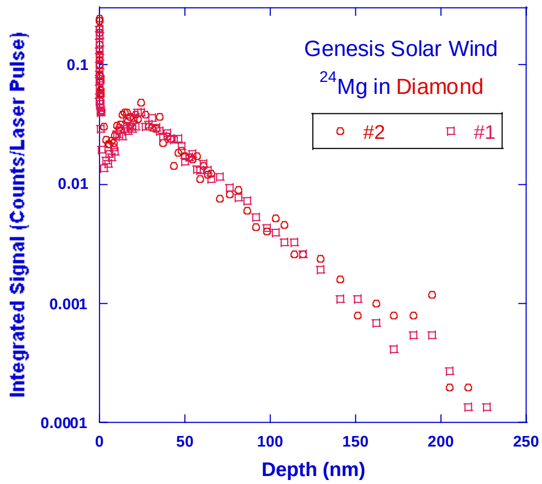

Figure 2. Mg concentration versus depth in Genesis Diamond Collectors as determined by RIMS on two separate sample locations.

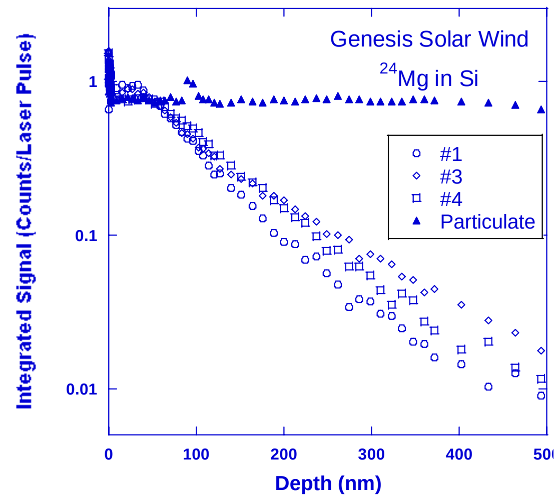

Figure 3. Mg concentration versus depth in Genesis Si collectors as determined by RIMS on three separate sample locations. A fourth location is contaminated by a particulate.

particulates too small to find optically we have found that the depth profiles are sufficiently obvious that such contaminated locations can easily be rejected. An example of this is displayed in **Fig 3**. Here the solid symbols display a location which was later determined to have a small particulate in the depth profile area.

To quantify the Mg concentration in the solar wind, measurements of composition versus depth were conducted on Genesis samples and compared to a standard. The standard consisted of a Si wafer and a DLC coated Si wafer each implanted with 43 keV ^{25}Mg at a dose of 1.10 × 10^{13} atoms/cm^2. Two Genesis samples from the C or D collector arrays (one Si and one DLC were cleaned using a Megasonic ultra pure water stream at Johnson Space Center (JSC) before being sent to Argonne National Laboratory (ANL). JSC has found that this cleaning procedure removes a substantial fraction of the surface particulate contamination (>50%), leaving areas as large as 500 µm in diameter particle-free at the ≥1 µm scale. Both the C and D collector arrays of Genesis were exposed to the solar wind for the entire 27 months that the collection canister was open and thus should represent the average solar wind over that time.

The ^{24}Mg dose in the Genesis sample was quantified by integrating the measured depth profile and scaling the result by the integrated depth profile of the implant standard and the implant dose. The measured values obtained are displayed in **Table 1**.

The new dose determinations are in line with expected results [1] and since they have been made on several samples types and several spots are preferred over our previous preliminary number particularly since significant improvements in both the instrument and the methodology of measuring depth profiles have been made over the past year. Isotope ratios are terrestrial within error.

Table 1. Measured Mg fluences as a function of isotope, sample location, and flight sample type. Fluence units are 10^{12} ions/cm^2. Errors are ~20%.

	^{24}Mg	**^{25}Mg**	**^{26}Mg**	**Mg**
Si #1	1.85	0.208	0.212	2.27
Si #2	1.97	0.236	0.257	2.46
Si #3	1.94	0.232	0.248	2.42
Dmd #1	2.82	0.295	0.307	3.42
Dmd #2	2.84	0.319	0.341	3.50
Average	2.28	0.258	0.273	2.81

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